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Integration of Problem-Based Learning and Number Monopoly: Strategies for Improving Elementary School Students' Mathematical Literacy

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ABSTRACT

Purpose – Mathematical literacy is an essential competency for every student as it plays a vital role in understanding and solving mathematical problems. However, in practice, this ability remains relatively low among elementary school students. This study aims to investigate improvements in mathematical literacy among second-grade students through the implementation of the Problem-Based Learning (PBL) model, supported by the Monopoly Number Game as a learning medium.

Methodology – The research employed a Classroom Action Research (CAR) design, conducted in two cycles, with 21 second-grade students of SD Negeri 3 Bancarkembar as the participants. Data were collected through tests and observations to assess students' development of mathematical literacy.

Findings – The findings reveal a significant improvement after applying PBL with the monopoly game. The Percentage of students' mathematical literacy increased from 33.33% in the pre-cycle to 57.14% in the first cycle and reached 85.71% in the second cycle. These results demonstrate that integrating the PBL model with an engaging game-based medium can foster meaningful, enjoyable, and effective learning, ultimately enhancing elementary school students' mathematical literacy.

Contribution – The study's findings suggest that an innovative integration of PBL and educational games can be an alternative strategy to improve students' literacy skills in mathematics at the primary school level.

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INTRODUCTION

The need to develop high-quality and highly competitive human resources is becoming increasingly urgent for a nation. Excellent human resources play an important role in national development and are key to a country's ability to compete globally. However, the Institute for Management Development (IMD) World Competitive Yearbook 2022 report ranks Indonesia's human resource competitiveness 44th out of 63 countries. (IMD, 2022). This situation shows that the government's efforts to build an investment and education ecosystem still face significant challenges (Herlina et al., 2025). One of the main factors contributing to this low competitiveness is the quality of education. According to Simarmata, education is a planned learning process aimed at improving the quality of human life. (Simarmata, Y., Wedyawati, N., & Rejeki Hutagaol, 2020). In recent years, the government has begun implementing 21st-century learning in formal education, emphasizing mastery of key skills such as critical thinking, creativity, communication, collaboration, citizenship, and character development. The implementation of these skills is expected to equip students to compete globally.

Analytical and critical thinking skills are essential for students' future. Critical thinking is the ability to analyze, evaluate, reconstruct, and make logical decisions. (Mardhiyah, R. H., Fajriyah Aldriani, S. N., Chitta, F., & Zulfikar, 2021). With these skills, students not only think passively but also solve problems through a deeper understanding. One field relevant to honing critical thinking skills is mathematics. Mathematics is not just memorization; it requires reasoning, problem-solving, and logical and systematic thinking. The National Council of Teachers of Mathematics (NCTM) has established five competencies that must be achieved in mathematics learning: reasoning, problem-solving, connecting, communicating, and representing. (Madyaratri, D. Y., Wardono, & Prasetyo, 2019). This competency is embodied in the concept of mathematical literacy, defined as the ability to formulate, use, and interpret mathematics across various contexts. Mathematical literacy enables students to reason, use concepts and procedures, and make reflective decisions in everyday life. (Kolar, V. M., & Hodnik, 2021). One of the skills society needs to compete in the 21st century is mathematical literacy. Mathematics is not only knowledge, but also the ability to use mathematical skills effectively. Mathematical literacy skills can motivate students to connect mathematical ideas and symbols with everyday situations. (Daulay, 2023). However, international studies, such as the Trends in International Mathematics and Science Study (TIMSS), show that Indonesian students' mathematical literacy remains low. According to an IEA report, Indonesian students' achievements are well below the international average (Hadi, S., & Novaliyosi, 2019). This low achievement is due to students' tendency to solve problems procedurally, without engaging in logical reasoning, even though TIMSS questions require thinking skills in the domains of knowledge, application, and reasoning. In addition, differences in mathematical-logical intelligence also affect students' mathematical literacy. Purwanti states that students with high mathematical-logical intelligence can formulate problems, choose strategies, and apply mathematical concepts effectively. (Hadi, S., & Novaliyosi, 2019). Conversely, students with low intelligence require more guidance because they struggle to meet the indicators of mathematical literacy. Mathematical literacy is a fundamental skill students need to develop to succeed and thrive in the learning process (Kusuma et al., 2022).

Good mathematical literacy is linked to improved critical thinking skills, which are among the most sought-after competencies today (Rahma et al., 2024; Amanda et al., 2024; Agusdianita et al., 2024). The Program for International Student Assessment (PISA) measures students' mathematical literacy by assessing their ability to: reason mathematically; understand computational thinking concepts; formulate, use, and interpret mathematics in various contexts; describe, explain, and predict phenomena; and recognize the role of mathematics in the world (Rahma et al., 2024). Numbers are one of the topics closely related to mathematical literacy. Students are required to formulate problems into mathematical models, select relevant information, and use arithmetic operations to find solutions. In mathematical literacy, there are three main indicators, namely formulating mathematical situations, applying procedures and reasoning, and interpreting and evaluating results. Various scientific studies show that students' mathematical literacy skills, especially among

elementary school students, are unsatisfactory (Yekti & Mufarrihah, 2022; Firdaus et al., 2023; Ananda & Wandini, 2022; Harahap et al., 2022). Many teachers are still unable to create a pleasant learning environment for students. In addition, the lack of learning media makes it difficult for students to understand the subject matter (Desyawati et al., 2021).

The evaluation conducted in grade II at SD Negeri 3 Bancarkembar showed that some students obtained scores below the minimum passing grade (KKM) in mathematics. The majority of students were only able to copy information from the questions without being able to solve them or draw accurate conclusions. Based on these conditions, innovation in more effective learning models and media is needed. One potential alternative is applying the Problem-Based Learning (PBL) model, using number monopoly media, to improve the mathematical literacy of elementary school students. There is quite a lot of research on the application of the PBL model that has a positive impact on children's mathematical abilities. However, the integration of number monopoly media into the PBL model is still relatively rare. This research aims to apply the PBL model, integrating number monopoly media, to improve elementary school students' mathematical literacy.

The main problem in this study is the low level of mathematical literacy among elementary school students in Indonesia, particularly in lower grades. Results from international studies, such as TIMSS, show that Indonesian students' mathematical literacy remains well below the international average. This condition indicates that students tend to be able to solve problems procedurally but have difficulty with those that require reasoning, concept application, and problem-solving. In addition, the results of the mathematics learning evaluation in grade II at SD Negeri 3 Bancarkembar show that many students still score below the Minimum Passing Grade (KKM). Most students can only write down the information in the questions, but are not yet able to apply mathematical concepts to solve problems or draw conclusions. This shows that mathematical literacy indicators, particularly in the aspects of application, interpretation, and evaluation of results, have not been optimally achieved.

Many studies have been conducted on mathematical literacy, especially in relation to the application of the PBL model in order to improve critical thinking, problem solving, and mathematical reasoning skills (Erika Setiowati et al., 2024; Suradika et al., 2023; Kök & Duman, 2023), (Susilawati & Supriyatno, 2023). Several previous studies (Kolar & Hodnik, 2021; Fitriani & Setyaningsih, 2024) emphasize the importance of mathematical literacy as a foundation for students in facing global challenges. International assessments such as TIMSS show that Indonesian students have low levels of mathematical literacy, underscoring the urgency of developing effective learning strategies.

Problem-Based Learning (PBL) is recognized as one of the most effective learning models for honing critical thinking, collaboration, and problem-solving skills. (Kartikasari et al., 2021), (Kurniasih et al., 2020), (Lestari et al., 2024), (Admoko, 2019). Several studies confirm the effectiveness of PBL in improving critical thinking skills and mathematical literacy (Asri et al., 2024). Previous research also shows that Problem-Based Learning (PBL) has been proven effective in improving the quality of mathematics teaching and learning for pre-service teachers in Ghana (Boye & Agyei, 2023). Problem-based learning combined with media innovation can also increase student motivation to learn (Wijnia et al., 2024; Putri Assani Rohmatus Sa'adah & Agung Nugroho, 2020).

Numerous studies have examined the application of the Problem-Based Learning (PBL) model in mathematics education, and these studies have proven effective in enhancing students' critical thinking, reasoning, and problem-solving skills; however, most still rely on conventional learning materials, such as worksheets or printed teaching materials. On the other hand, research integrating PBL with educational games, particularly number monopoly, remains very limited, especially among lower-grade elementary school students. In fact, second-grade students are at the concrete operational stage of development and therefore require contextual, interactive, and engaging learning materials to understand mathematical concepts better and stay motivated in their learning. Furthermore, the low level of mathematical literacy among Indonesian students, as indicated by the TIMSS results, highlights the need for educational innovations that focus not only on outcomes but also on students' ability to formulate, apply, and interpret mathematical

concepts in everyday life. Therefore, research on integrating the Problem-Based Learning model with number monopoly games is essential to create a more engaging, meaningful, and effective mathematics learning experience that enhances elementary school students' mathematical literacy.

The novelty of this study lies in integrating the Problem-Based Learning (PBL) model with the educational "Number Monopoly" game to improve the mathematical literacy skills of lower-grade elementary school students. Unlike previous studies, which generally used conventional teaching methods, this study presents a more interactive, contextual, and enjoyable approach to mathematics instruction, tailored to the cognitive development characteristics of second-grade elementary school students. In addition, this study specifically focuses on improving mathematical literacy, including the ability to formulate, apply, and interpret mathematical concepts in everyday situations through problem-based educational games.

The purpose of this study was to determine the extent to which the application of the Problem-Based Learning model with number monopoly media could improve the mathematical literacy of second-grade elementary school students. This study not only describes the process of applying the model and media in mathematics learning but also analyzes the improvement in mathematical literacy achieved by students after participating in the learning process. In addition, this study aims to provide innovative, enjoyable, and effective alternative learning strategies that can help overcome low mathematical literacy among students, especially in number-related material in elementary school.

METHODOLOGY

Research Design

The research used in this study was Classroom Action Research (CAR), conducted in a classroom environment to improve the learning process and quality through systematically designed actions. (Kunandar, 2013). The research was conducted at SD Negeri 3 Bancarkembar with all 21 second-grade students and their teachers as subjects. The research process consisted of two cycles, each comprising one meeting. The action research model used referred to the design by Kemmis and McTaggart, which included four main stages, namely: (1) planning, (2) implementation of actions, (3) observation, and (4) reflection (Kemmis, S., & McTaggart, 1988). Through this cycle, it was hoped that there would be continuous improvement in the learning process, so that the improvement in students' mathematical literacy skills could be clearly measured.

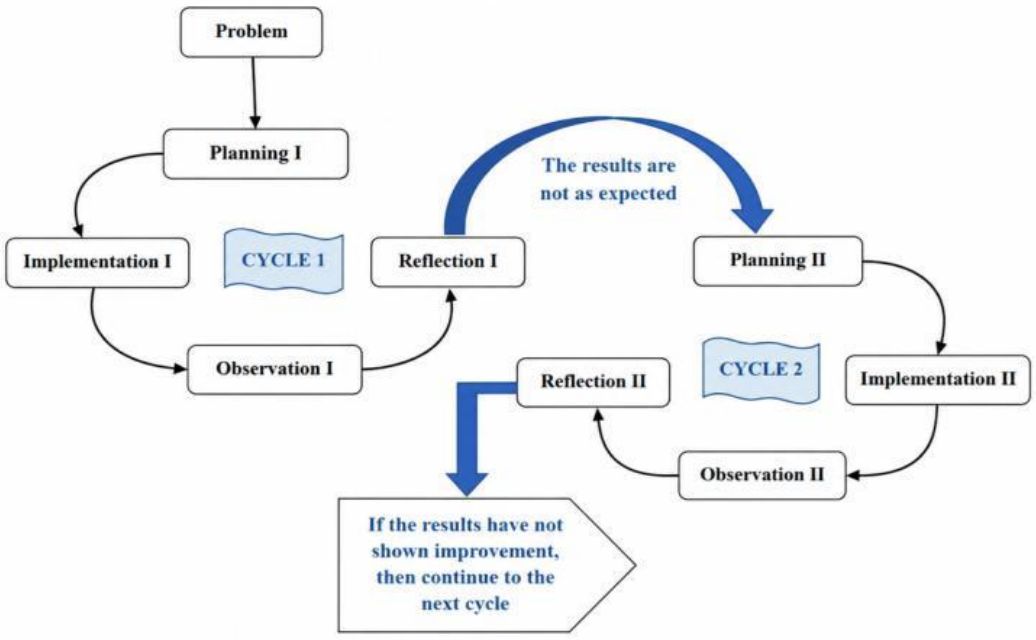

Figure 1. Classroom Action Research Cycle

Participant

The data sources for this study were 21 second-grade students at SD Negeri 3 Bancarkembar, Bayumas, Central Java, who served as the main subjects, as well as teachers who acted as researchers and implementers of the learning activities. Class placement was based on preliminary data showing that the majority of students scored below the minimum passing grade on number-related material. Students were only able to simplify real-life situations into variables and symbols by writing down the information in the questions; however, they still struggled to write out solutions and draw conclusions.

Data Collection

The data in this study were used to determine how to improve students' mathematical literacy skills through the implementation of problem-based learning using number monopoly media. The techniques used in data collection were as follows: (1) Observations were carried out during the learning process. Observations were made by observing and recording all activities carried out by students. The observation was used to assess the implementation of the Problem-Based Learning model using number monopoly as a teaching aid. (2) Tests were conducted to measure students' mathematical literacy skills after implementing the problem-based learning model assisted by the number monopoly media. The tests were in essay form, based on predetermined indicators.

Data Analysis

Analysis of Observation Results

The observation data were analyzed using a five-point scoring scale: 5 = Excellent, 4 = Good, 3 = Fair, 2 = Poor, and 1 = Very Poor. The scores were based on the suitability of the learning implementation within the Problem-Based Learning model and the number of media used. Thus, the observation analysis provided an overview of the quality of learning implementation and student activities during the process.

Test Result Analysis

The test results were analyzed to determine the improvement in students' mathematical literacy in each cycle. The analysis was carried out by calculating percentages for individual scores, class averages, learning quantities, and mastery classifications based on predetermined criteria. Using this technique, it was possible to assess the extent of improvement in students' mathematical literacy from the pre-cycle to the next cycle.

Individual Score: $S = \frac{R}{N}$ x100

S = Value to be found

R = Total score for correct answer

N = Maximum Score

Class Average: $Score = \frac{\sum x}{N}$ X 100

$\sum$x = Total Score Obtained

N = Maximum Score

Learning Achievement: $P = \frac{F}{N}$ x100

P = Percentage of learning achievement

F = number of test items

N = Total number of students

FINDINGS

Pre-Cycle

This study aims to improve second-grade students' mathematical literacy by applying the problem-based learning model. Before the intervention was implemented, the researcher first conducted conventional learning to obtain an overview of the initial conditions of mathematics learning in the subject of numbers. Next, students were given evaluation questions to assess their mathematical literacy. Based on the pre-cycle evaluation results, the average mathematical literacy score was 65.9. Of the 21 students, only 7 (33.33%) met the success criteria, while 14 (66.67%) remained below the set standard and were therefore classified as low. This condition shows that most students have not achieved the expected mathematical literacy skills. Therefore, the teacher felt the need to make improvements by applying a problem-based learning model assisted by multimedia.

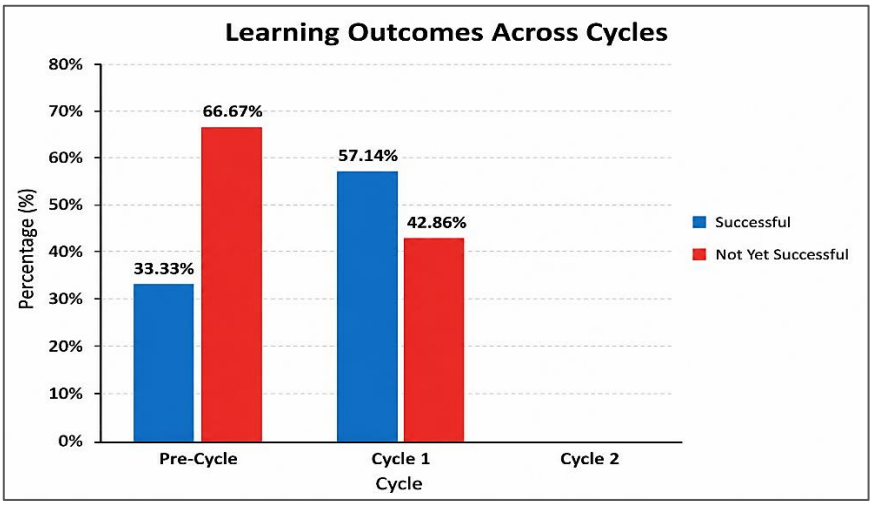

Figure. Pre-cycle Assessment Results

Cycle I

Planning

During the planning stage, teachers develop learning strategies to address problems identified in the initial conditions, namely low student activity and low mathematical literacy. To overcome this, teachers designed the learning process using a problem-based learning model, supported by multimedia. In their planning, teachers developed teaching modules tailored to the learning outcomes of phase A, namely the ability to understand numbers up to 100 through reading, writing, comparing, sorting, and arranging and decomposing numbers.

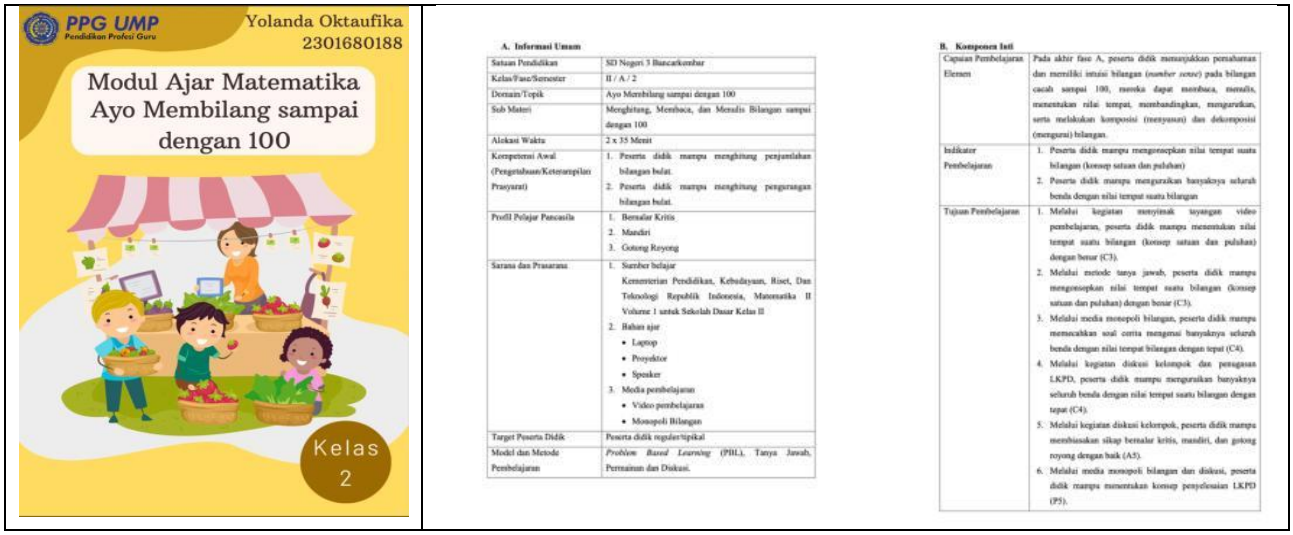

Figure 3. Teaching Module

The indicators set included the ability to conceptualize place value and the skill of decomposing numbers into their constituent objects based on their place value. In addition, the teacher also prepared number monopoly media, student worksheets (LKPD), and observation sheets to assess the implementation of learning in group discussions. To complete this stage, the teacher designed individual evaluation questions to measure students' mathematical literacy achievements at the end of cycle 1.

Figure 4. Worksheet Cycle 1

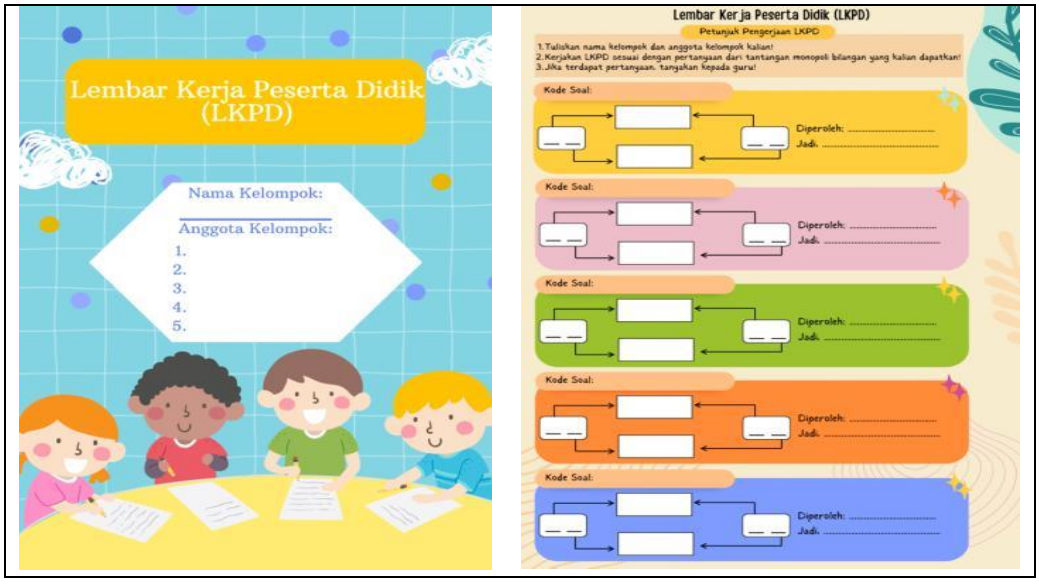

Figure 5. Worksheet Cycle 2

Action

At the beginning of the activity, the teacher opened the lesson with a greeting, a prayer together, and attendance-taking, then invited the students to sing the song "*Satu Nusa Satu Bangsa*". After that, the teacher asked stimulating questions and explained the learning objectives. After entering the main activity, the teacher showed a video on counting problems and asked questions related to its content. Although some students seemed unfocused, the teacher immediately got them back on track. Next, the students were divided into groups to work on worksheets using number monopoly as a medium. The teacher explained the rules of the game in detail, guided the discussion, and monitored the students' involvement in the groups. The game

ended when one group answered five questions correctly, and the winner was determined by the group that gave the most correct answers. After that, each group presented the results of its discussion, and the other groups were allowed to respond. During the presentation, some students still were not taking it seriously, but the teacher redirected them. After the presentation, the teacher and students expressed their appreciation with applause. The teacher also reiterated the solution to the game's problem and provided feedback on the answers. In the closing activity, the teacher distributed individual evaluation questions to assess students' understanding, then led a reflection by asking them to reflect on what they had learned during the meeting. To end the activity on a cheerful note, the students sang the song *Anak Kambing Saya*, then prayed together, and finally, the teacher closed the lesson with a greeting.

Observation

Observations were conducted using observation sheets for teachers and students during learning using the problem-based learning model assisted by number monopoly media. The results of teacher observations showed that most of the learning steps were carried out well, with a total score of 67 (83.75%). Meanwhile, the results of student observations obtained a score of 61, or 76.2%. Although the Percentage of implementation was quite good, the application of the PBL model in cycle I was not entirely as expected, especially in the stage of developing and presenting the results, which still encountered obstacles. This indicates the need for improvement in the next cycle.

Table 2. Results of the Observation of the Implementation of the PBL Model in Cycle I

No.	Learning Activities	Teacher Score	Teacher (%)	Student Score	Student (%)
1	Introduction	25	83.3	23	76.6
2	Orienting students to the problem	8	80.0	7	70.0
3	Organizing students for learning	8	80.0	7	70.0
4	Guiding individual and group investigation	4	80.0	4	80.0
5	Developing and presenting work results	4	80.0	3	60.0
6	Evaluating the problem-solving process	4	80.0	4	80.0
7	Closing	14	93.3	13	86.6

In terms of mathematical literacy, the evaluation at the end of cycle I showed that the average class score reached 76.67. A total of 12 out of 21 students (57.14%) successfully met the completion criteria, while 9 students (42.86%) did not reach the target. Thus, it can be concluded that the application of PBL assisted by number monopolies began to show improvement. However, it was not yet evenly distributed, so it needed to be improved further in cycle II.

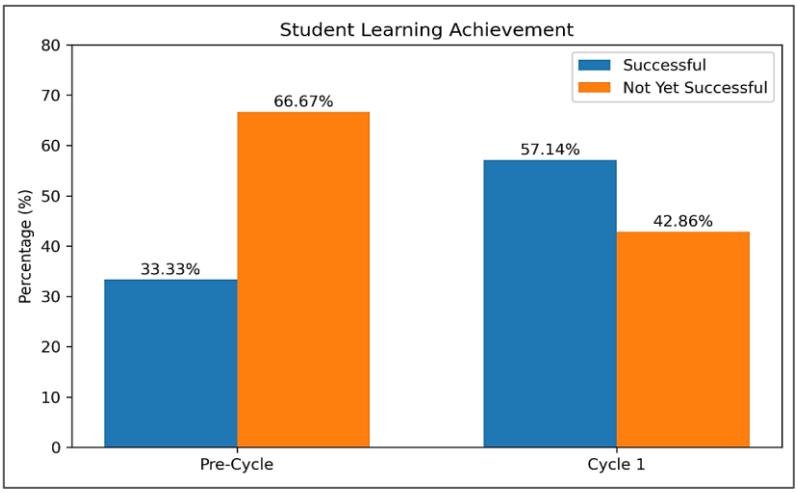

Figure 6. Results of the Cycle 1 Mathematics Literacy Assessment

Reflection

The reflection stage involved evaluating the mathematics learning process to assess improvements in students' mathematical literacy. The assessment results showed improvement from the pre-cycle to cycle I, both in evaluation results and in learning implementation. However, this improvement had not yet achieved optimal results, so the research continued to cycle II with several improvements. The improvements made included rearranging group formation, increasing guidance and direction so that all members could work together effectively, creating a more engaging yet controlled discussion atmosphere, and improving time allocation so that learning activities occurred more regularly as planned.

Cycle 2

Planning

At the beginning of the lesson, the teacher greets the students to create a conducive atmosphere, then invites all students to pray together for a smooth learning process. Next, the teacher takes attendance to determine student attendance. After that, the teacher invites the students to sing the *Garuda Pancasila* song to foster enthusiasm and a sense of nationalism before entering the material. Before the main lesson begins, the teacher asks questions related to the topic to be studied, then explains the learning objectives to help students understand the direction of the learning activities.

Action

At the beginning of the lesson, the teacher opened the class with a greeting, prayer, and attendance check. After that, the teacher invited the students to sing the Garuda Pancasila song and asked some questions before explaining the learning objectives. In the main activity, the teacher showed a video comparing two numbers and then asked questions related to its content. Next, students are divided into small groups to work on worksheets using a number monopoly game. The teacher explains the rules of the game, guides the discussion, and monitors student involvement in the group. The game ends when one of the groups completes five questions, and the discussion results are presented to the class. The teacher facilitated the presentation, allowed other groups to respond, and expressed appreciation, reinforcing students' answers and the discussion's outcomes. In the closing activity, the teacher gave an evaluation question to be completed individually, then conducted a reflection by asking questions about what had been learned. Before closing the lesson with a prayer and a greeting, the teacher invited the students to sing the song "*Cublak-Cublak Suweng*" to conclude the activity.

Observation

Based on observations of the implementation of the Problem-Based Learning (PBL) model assisted by number monopoly media in cycle II, both teachers and students showed significant performance improvement. The observations were conducted by one observer using observation sheets differentiated for teachers and students. The teacher observation sheet was used to see the extent to which teachers implemented PBL syntax with number monopoly media. In contrast, the student observation sheet was used to monitor student involvement during the learning process. The results of the observation showed that in the preliminary stage, teachers scored 93.3% while students scored 83.3%. In the problem orientation step, teachers scored 90%, and students scored 80%. The activity of organizing students also yielded the same scores: 90% for teachers and 80% for students. In the stage of guiding individual and group investigations, teachers achieved a 100% score, while students scored 80%. The steps to develop and present the results were achieved with a score of 80% for both teachers and students. The evaluation of the problem-solving process was conducted well, with both teachers and students achieving a 100% score. In the closing activity, teachers scored 100%, and students scored 93.3%. Overall, these data show that implementing PBL syntax with number monopoly media in cycle II was optimal, with teachers consistently carrying out each stage and students being active. However, a small number still did not perform optimally.

Table 3. Results of the Observation of the Implementation of the PBL Model, Cycle 2

No.	Learning Activities	Teacher Score	Teacher (%)	Student Score	Student (%)
1	Introduction	28	93.3	25	83.3
2	Orienting Students to the Problem	9	90.0	8	80.0
3	Organizing Students for Learning	9	90.0	8	80.0
4	Guiding Individual and Group Investigation	5	100.0	4	80.0
5	Developing and Presenting Work Results	4	80.0	4	80.0
6	Evaluating the Problem-Solving Process	5	100.0	5	100.0
7	Closing	15	100.0	14	93.3

In terms of mathematical literacy achievement, the evaluation results at the end of cycle II showed a significant increase compared to the pre-cycle and cycle I. The class average score in cycle II reached 86.33. A total of 18 out of 21 students (85.71%) met the success criteria, while 3 students (14.28%) did not. Compared with previous data, there was a clear improvement: in the pre-cycle, only 33.33% of students were successful, increasing to 57.14% in cycle I and to 85.71% in cycle II. The histogram presented reinforces the picture of a positive trend from the pre-cycle to cycle II, both in the increase in the number of successful students and the significant decrease in the number of unsuccessful students. Thus, it can be concluded that the application of the PBL model, supported by various media, in cycle II increased student engagement in the learning process and positively affected their mathematical literacy skills.

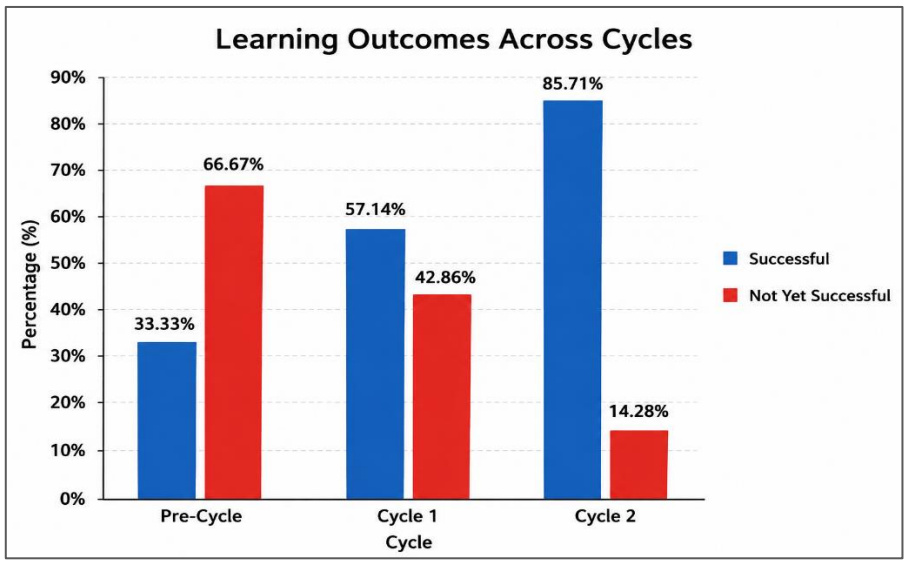

Figure 7. Results of the Cycle 1 Mathematics Literacy Assessment

Reflections

Reflections conducted after the end of cycle II showed an increase in students' mathematical literacy. Students were able to relate problems to mathematical forms, use concepts, facts, procedures, and reasoning, and interpret the results of their solutions well. This confirms that varying learning models and media play an important role in maintaining enthusiasm for learning, so that activities do not feel monotonous and are more interesting for students. Teachers are also required to continue innovating so that learning remains enjoyable and motivating for students. The results of the mathematical literacy assessment showed an increase in completeness of 28.57%, from 57.14% in cycle I to 85.71% in cycle II. This achievement exceeded the predetermined success criteria, so the research was considered to have achieved its objectives and did not need to be continued to the next cycle.

DISCUSSION

This classroom action research focuses on the application of the Problem-Based Learning (PBL) model, supported by number monopoly media, as an innovation in mathematics learning in elementary schools. The main objective of this study is to improve students' mathematical literacy through active, collaborative, and contextual learning. This discussion examines aspects of planning, implementation, teacher and student activities, and improvements in learning outcomes from the pre-cycle to cycle II. In general, the study's results show a significant increase in students' mathematical literacy and positive changes in the dynamics of the teaching and learning process. This success is inseparable from the two main components of learning innovation: the application of the Problem-Based Learning model and the use of multimedia. The combination of the two provides a fun and meaningful learning experience, thereby increasing student engagement in the mathematics learning process.

The success of implementing actions begins with careful planning through the development of PBL-based teaching modules. These modules are developed in accordance with the principles of differentiated learning. They are designed to achieve the mathematics literacy indicators adapted from the OECD (2021), namely: (1) formulating situations in mathematical terms, (2) applying concepts, facts, and procedures, and (3) interpreting the results of solutions contextually. These indicators help teachers guide learning that emphasizes not only procedural skills but also higher-order thinking skills (HOTS) in everyday contexts. The PBL syntax used consists of five main stages: orienting students to the problem, organizing students to learn, guiding individual and group investigations, developing and presenting work results, and analyzing and evaluating the problem-solving process. In this context, number monopoly media is used to support the investigation and group discussion stages through structured educational game activities. One of the strengths of this study lies in the use of number monopoly media as a learning innovation. This media was developed by adapting the principles of the popular Monopoly game and contextualizing them in mathematics material, particularly number operations and problem-solving. Through this media, students actively learn mathematics through game mechanics, where each step of the game contains challenges in the form of contextual questions or problems that must be solved collaboratively.

Figure 8. Monopoly Number Media

This innovation sets it apart from previous studies that applied the PBL model conventionally without the support of game media. Number Monopoly integrates cognitive, affective, and psychomotor aspects into a single activity. Activities such as throwing dice, stepping, reading challenge cards, and solving problems

make learning interactive, fun, and meaningful. The use of media and innovative learning models can increase student motivation and active participation, as well as facilitate the internalization of abstract concepts (Putri Sabiq Shidiqia Rabany et al., 2025; Evelyn et al., 2025; Nugroho & Azizah, 2024). In addition, number monopoly games also encourage social interaction and collaboration among students. This aligns with the principle of collaborative learning in PBL, where students are not only recipients of information but also active learners who share ideas and strategies. The PBL model helps students build their own knowledge through meaningful learning experiences (Prastika et al., 2024; Sastrawati & Budiono, 2025). In this study, these experiences were realized through play-based learning activities using number monopoly media. The application of monopoly media is a concrete example of learning-based approaches, in which learning styles significantly influence students' mathematical literacy. (Ayuningtyas & Nurafni, 2025). The integration of game media, such as Number Monopoly, into PBL is an effective approach to building an active, student-centered, enjoyable, and meaningful learning environment for mathematical literacy. (Hamidah et al., 2025), (Ahmad Gufron et al., 2025), (Liana et al., 2023).

Number monopoly media help students practice flexible thinking, collaboration, and active problem-solving in mathematics, thereby improving mathematical literacy and developing social skills and 21st-century learning competencies. Quantitative results show that using the PBL model, assisted by number monopoly, leads to a significant improvement in students' mathematical literacy. The average student score increased from 65.9 in the pre-cycle to 76.67 in cycle I, and rose again to 86.33 in cycle II. The Percentage of mastery also increased from 33.33% in the pre-cycle to 57.14% in cycle I, and reached 85.71% in cycle II.

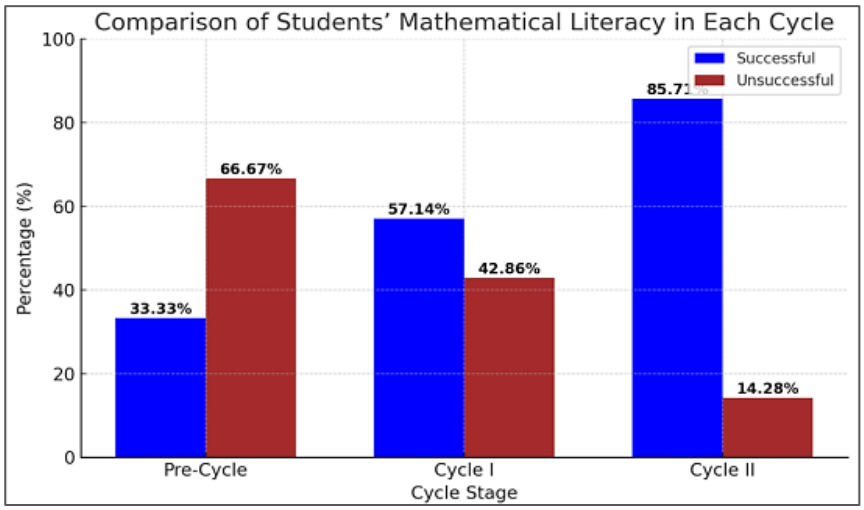

Figure 9. Results of Students' Mathematical Literacy Test

Figure 9 above shows the results of the students' mathematical literacy test from the pre-cycle stage to cycle II. Based on the graph, there was a significant increase, and the success criteria were achieved after the implementation of the Problem-Based Learning (PBL) model assisted by the number monopoly media. In the pre-cycle stage, only 33.33% of students met the success criteria, while 66.67% did not meet the mastery standards. This condition shows that most students still had difficulty understanding basic mathematical concepts and did not demonstrate optimal mathematical literacy. After the intervention in cycle I, there was an improvement. The Percentage of students who successfully met the criteria increased to 57.14%, while the Percentage of students who did not succeed decreased to 42.86%. This increase shows that the application of the PBL model has begun to have a positive impact on students' ability to understand and apply mathematical concepts through problem-solving activities. However, student learning activities at this stage were not yet fully optimal, as some students remained passive in group discussions and did not fully relate contextual problems to mathematical representations.

Improvements were made in cycle II by increasing student engagement through more focused learning strategies, consistent motivation, and more effective use of number monopoly media. At this stage, mathematics literacy results showed a greater increase, with 85.71% of students meeting the success criteria, while only 14.28% did not complete the cycle. These results confirm that learning with the PBL model, supported by various media, can significantly improve students' mathematics literacy. Overall, the graph shows a consistent upward trend from the pre-cycle to cycle II. This indicates that combining the Problem-Based Learning model with number monopoly media can create a more enjoyable learning experience, increase learning motivation, and strengthen students' abilities to understand, reason, and apply mathematical concepts in context. Thus, the innovation of number monopoly media can be said to be effective in supporting the achievement of mathematics learning objectives in elementary schools, particularly in the aspect of mathematical literacy. This improvement shows that applying PBL gradually increases student participation and responsibility for learning. In cycle I, some students were still unfamiliar with working in groups and tended to be passive. However, in cycle II, students began to get used to discussing, to dare express their opinions, and to actively participate in number monopoly games. Teachers' activities also improved, from simply giving instructions to becoming facilitators who guided the discussion and directed students in finding solutions independently.

The improvement in students' mathematical literacy in this study was influenced not only by the application of the Problem-Based Learning (PBL) model but also by the characteristics of the number monopoly media appropriate to the cognitive development stage of lower-grade elementary school students. Second-grade elementary school students are at the concrete operational stage, so learning will be easier to understand when presented through real, visual, and fun activities. The use of the number monopoly game makes previously abstract mathematical concepts more concrete through activities such as rolling dice, moving maps, reading question cards, and solving challenges directly. The game-like learning environment also creates a more relaxed, less stressful atmosphere, so students are more confident in trying, asking questions, and expressing opinions. This condition is one of the factors that causes increased learning motivation and active student involvement during the learning process.

In addition to increasing learning motivation, playing with Monopoly Numbers also helps develop students' mathematical reasoning and problem-solving skills. Each challenge in the game requires students to understand information, choose a solution strategy, and explain the reasons for their answers. This process trains students not only to memorize procedures but also to think logically and use mathematical concepts contextually. When students discuss their answers with their groups, a simple exchange of ideas and arguments occurs that indirectly strengthens their mathematical literacy, particularly in formulating problems, applying concepts, and interpreting solution results. Thus, the mechanism for improving mathematical literacy in this study occurred through a combination of play activities, problem-solving, social interaction, and reflection on the answers obtained.

Group discussions within the PBL framework also play a crucial role in fostering students' mathematical literacy. Through group work, students learn to express their ideas, listen to their peers' opinions, and collaborate to solve given problems. This activity helps students develop a deeper understanding of mathematics because knowledge is gained not only from teacher explanations but also from the process of negotiating meaning with peers. At the beginning of the study, some students were still passive and dependent on more active peers. However, in cycle II, changes in learning behavior were observed, with students becoming more willing to ask questions, provide opinions, and engage in problem-solving. These changes demonstrate that implementing PBL with the aid of number monopoly not only improves learning outcomes but also develops students' communication skills, collaboration, and self-confidence in mathematics.

The use of number monopoly media has been proven to create a more conducive and enjoyable learning atmosphere. Students who were initially unfocused and passive became more enthusiastic because the learning activities resembled games. Thus, number monopoly serves not only as a visual aid but also as an innovative pedagogical strategy that integrates gamification into basic mathematics learning. The results of

this study reinforce several previous findings on the effectiveness of the PBL model in improving students' critical thinking and mathematical literacy. However, the new contribution of this study lies in the innovative use of number monopoly media as a form of contextual adaptation of the PBL model at the elementary school level. While previous studies have focused more on conceptual approaches and problem-based discussions, this study adds an educational game element to build students' emotional and social engagement during the learning process. The application of learning models that foster independent learning, such as PBL supported by interactive media, can improve students' mathematical literacy. (M. Duskri et al., 2024), (Maslihah et al., 2021), (Hidajat, 2023). These findings also reinforce previous research indicating that the use of innovative, contextual, and interactive learning media, whether based on ethnomathematics or on educational games such as Number Monopoly, has been proven effective in improving elementary school students' mathematical literacy skills. (Yuslia Fendy et al., 2025). The implementation of the Problem-Based Learning model, enriched with appropriate learning media, will improve students' higher-order thinking skills and problem-solving abilities in both physics and basic mathematics contexts (Wiratama et al., 2025; Iwan et al., 2025) (Monsang et al., 2021) (Gumisirizah et al., 2024). Thus, integrating PBL and number monopoly media not only improves learning outcomes but also changes students' attitudes and learning behaviors. They become more focused, collaborative, and show greater interest in learning mathematics.

The results of this study are similar to those of previous studies, indicating that the PBL model is effective in improving students' critical thinking, problem-solving, and mathematical literacy. Previous studies generally found that PBL can encourage students to be more active in discovering concepts and solving contextual problems. However, this study differs in the use of number monopoly media to support PBL implementation in lower elementary school students. Most previous studies still use conventional media, such as student worksheets or printed teaching materials. In contrast, this study combines a problem-based approach with an interactive educational game appropriate to the developmental characteristics of elementary school-aged children. The unique contribution of this study lies in integrating the PBL model and game-based learning through number monopoly media to improve mathematical literacy among second-grade elementary school students. This integration has been proven not only to improve students' academic abilities but also to create a more enjoyable, active, collaborative, and meaningful learning experience.

CONCLUSION

Based on observations, reflections, and data analysis from pre-cycle to cycle II, it can be concluded that the application of the Problem-Based Learning (PBL) model, supported by number monopoly media, is effective in improving second-grade students' mathematical literacy skills at SD Negeri 3 Bancarkembar. This improvement is seen in students' abilities to formulate problems in mathematical form, use mathematical concepts and procedures appropriately, and interpret the results of problem-solving in everyday contexts. In addition, the application of PBL, assisted by number monopoly, can improve students' problem-solving and mathematical reasoning skills through discussion activities and educational games that require active, collaborative thinking. The results of the study showed an increase in the average value of mathematical literacy from 65.9 in the pre-cycle to 76.67 in cycle I, and then to 86.33 in cycle II. The Percentage of learning completeness also increased significantly from 33.33% in the pre-cycle to 85.71% in cycle II. In addition to improving learning achievement, the use of number monopoly media has been proven to increase students' active participation and enthusiasm in mathematics learning. Thus, integrating the PBL model and number monopoly media can be recommended as an alternative innovation in mathematics learning in elementary schools to support the development of students' mathematical literacy in a more active, enjoyable, and contextual manner.

REFERENCES

(IMD), I. for M. D. (2022). Institute for Management Development (IMD) World Competitive Yearbook. In *the International Institute for Management Development*.

Admoko, T. R. C. D. B. K. P. S. (2019). The effect of problem-based learning on critical thinking ability in mathematics education. *Journal of Physics: Conference Series*, *1157*(4), 112–122. https://doi.org/10.1088/1742-6596/1157/4/042063

Agusdianita, N., Danim, S., Susanta, A., Yusnia, Y., Izzania, R. D. S. M., & Irmayanti, M. (2024). Problem-Based Learning Materials Integrated with Differentiated Approaches to Enhance Elementary School Students' Learning Outcomes. *Profesi Pendidikan Dasar*, 161–182. https://doi.org/10.23917/ppd.v11i2.6441

Ahmad Gufron, Isti Hidayah, Ardhi Prabowo, Wardono, & Scolastika Mariani. (2025). The effectiveness of problem-based learning in enhancing mathematical literacy: A systematic meta-analysis. *Journal Elemen*, *11*(2), 483–501. https://doi.org/10.29408/jel.v11i2.30002

Amanda, F. F., Sumitro, S. B., Lestari, S. R., & Ibrohim. (2024). Enhancing Critical Thinking And Problem Solving Skills By Complexity Science-Problem Based Learning Model | Mejora del Pensamiento Crítico y las Habilidades para la Resolución de Problemas mediante el Modelo de Aprendizaje basado en la Complejidad de la C. *Multidisciplinary Journal of Educational Research*, *14*(1), 96–114.

Ananda, E. R., & Wandini, R. R. (2022). Analisis Kemampuan Literasi Matematika Siswa Ditinjau dari Self Efficacy Siswa. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, *6*(5), 5113–5126. https://doi.org/10.31004/obsesi.v6i5.2659

Asri, I. H., Jampel, I. N., Putu Arnyana, I. B., Suastra, I. W., & Nitiasih, P. K. (2024). Profile of Problem-Based Learning (PBL) Model in Improving Students' Problem-Solving and Critical-Thinking Ability. *KnE Social Sciences*, *2024*, 769–778. https://doi.org/10.18502/kss.v9i2.14898

Ayuningtyas, S., & Nurafni, N. (2025). The Influence of Learning Styles on Mathematical Literacy in Fifth-Grade Students: A Qualitative Study of Unit Measurement. *Plusminus: Jurnal Pendidikan Matematika*, *5*(2), 407–420. https://doi.org/10.31980/plusminus.v5i2.3034

Boye, E. S., & Agyei, D. D. (2023). Effectiveness of problem-based learning strategy in improving teaching and learning of mathematics for pre-service teachers in Ghana. *Social Sciences and Humanities Open*, *7*(1), 100453. https://doi.org/10.1016/j.ssaho.2023.100453

Daulay, K. M. R. M. B. S. L. A. (2023). Analisis Kemampuan Literasi Matematika Siswa. *OMEGA: Jurnal Keilmuan Pendidikan Matematika*, *2*(3), 142–148. https://doi.org/10.52484/as_sibyan.v6i2.526

Desyawati, K., Goreti, M., Kristiantari, R., Agung, G., & Negara, O. (2021). Media Permainan Monopoli Berbasis Problem Based Learning Pada Pembelajaran Tematik di Sekolah Dasar. *Jurnal Penelitian Dan Pengembangan Pendidikan*, *5*(2), 168–174. https://ejournal.undiksha.ac.id/index.php/JJL/index

Erika Setiowati, Syamsul Hadi, Maria Ulfa, Ahmad Dainuri, Fajar Sholeh, Miftahus Surur, & Zainul Munawwir. (2024). Analisis Kemampuan Literasi Matematika Dalam Meningkatkan Kemampuan Berpikir Kritis Siswa. *Jurnal Kajian Penelitian Pendidikan Dan Kebudayaan*, *2*(2), 55–68. https://doi.org/10.59031/jkppk.v2i2.321

Evelyn, N., Aldila, T., Nugroho, A., Studi, P., Guru, P., Dasar, S., & Purwokerto, U. M. (2025). *Upaya meningkatkan sikap kerjasama kelompok menggunakan model problem based learning (PBL) berbasis eksperimen materi bencana alam kelas V SDN Pahonjean 03*. *08*(05), 1052–1056.

Firdaus, N. M., & Takdir, M. (2023). Analisis Kemampuan Literasi Matematis Siswa Kelas V Sekolah Dasar. *Jurnal Pendidikan & Pembelajaran Sekolah Dasar*, *3*(1), 31–38.

Fitriani, D. A., & Setyaningsih, R. (2024). Peningkatan Literasi Matematis dalam Pembelajaran Matematika melalui Model Problem Based Learning pada Siswa Kelas XI. *Journal on Education*, *07*(01), 1494–1503.

Gumisirizah, N., Muwonge, C. M., & Nzabahimana, J. (2024). Effect of problem-based learning on students' problem-solving ability in learning physics. *Physics Education*, *59*(1). https://doi.org/10.1088/1361-6552/ad0577

Hadi, S, & Novaliyosi. (2019). Trends in International Mathematics and Science Study (TIMSS). *Prosiding Seminar Nasional & Call For Papers,* 562–569.

Hamidah, I., Zulkardi, P., R. I. I., & Pramuditya, S. A. (2025). Developing a Mathematical Literacy Learning Environment for Students through Educational Game Assistance. *Mathematics Education Journal*, *19*(1), 141–162. https://doi.org/10.22342/jpm.v19i1.pp141-162

Harahap, D. G. S., Nasution, F., Nst, E. S., & Sormin, S. A. (2022). Analisis Kemampuan Literasi Siswa Sekolah Dasar. Jurnal Basicedu, 6(2), 2089–2098. *Jurnal Basicedu*, *6*(2), 2089–2098.

Herlina, A., Syaifuddin, M., & Wurianto, A. B. (2025). Verbal Representation Abilities and Processes in HOTS Problem Solving Based on Adversity Quotient. *Jurnal Eduscience*, *12*(6), 1685–1700.

Hidajat, F. A. (2023). A comparison between problem-based conventional learning and creative problem-based learning on self-regulation skills: Experimental study. *Heliyon*, *9*(9), e19512. https://doi.org/10.1016/j.heliyon.2023.e19512

Iwan, I., Jeni, J., & Nurfathurrahmah, N. (2025). Biodiversity Module Based on Problem-Based Learning Local Wisdom Assisted by Augmented Reality : Improving Students' Critical Thinking. *Jurnal Eduscience*, *12*(2), 497–510.

Kartikasari, I., Nugroho, A., & Muslim, A. H. (2021). Penerapan Model PBL Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa Pada Kelas IV Sekolah Dasar. *Jurnal Gentala Pendidikan Dasar*, *6*(1), 44–56. http://online-journal.unja.ac.id/index.php/gentala

Kemmis, S., & McTaggart, R. (1988). *The Action Research Planner. Victoria Deakin University Press.* Victoria Dainkin University Press.

Kök, F. Z., & Duman, B. (2023). The effect of problem-based learning on problem-solving skills in English language teaching. *Journal of Pedagogical Research*, *7*(1), 154–173. https://doi.org/10.33902/JPR.202318642

Kolar, V. M., & Hodnik, T. (2021). Mathematical Literacy from the Perspective of Solving Contextual Problems. *European Journal of Educational Research*, *10*(1), 467–483. https://doi.org/https://doi.org/10.12973/EU-JER.10.1.467

Kolar, V. M., & Hodnik, T. (2021). Mathematical literacy from the perspective of solving contextual problems. *European Journal of Educational Research*, *10*(1), 467–483. https://doi.org/10.12973/EU-JER.10.1.467

Kunandar. (2013). *Langkah Mudah Penelitian Tindakan Kelas Sebagai Pengembangan Profesi Guru*. Rajawali Pers.

Kurniasih, P. D., Nugroho, A., & Harmianto, S. (2020). Peningkatkan Higher Order Thinking Skills (Hots) Dan Kerjasama Antar Peserta Didik Melalui Model Pembelajaran Problem Based Learning (Pbl) Dengan Media Kokami Di Kelas Iv Sd Negeri 2 Dukuhwaluh. *At-Ta'Dib*, *4*(1), 23–35. https://doi.org/10.32832/at-tadib.v4i1.19405

Kusuma, D., Sukestiyarno, Y. L., & ... (2022). Analisis Kemampuan Literasi Matematika pada Siswa Peserta Olimpiade. *Prosiding Seminar …*, 232–238. https://proceeding.unnes.ac.id/index.php/snpasca/article/view/1456%0Ahttps://proceeding.unnes.ac.id/index.php/snpasca/article/download/1456/956

Lestari, P. D., Baiduri, B., & Ummah, S. K. (2024). Problem-based learning with the iSpring-assisted inquiry method on critical thinking skills. *Journal of Education and Learning*, *18*(1), 148–153. https://doi.org/10.11591/edulearn.v18i1.21089

Liana, L., Kosim, K., & Taufik, M. (2023). Influence of the Problem-Based Learning Model Assisted by PhET Simulations on Students' Problem-Solving Abilities and Mastery of Physics Concepts. *AMPLITUDO : Journal of Science and Technology Innovation*, *2*(2), 101–107. https://doi.org/10.56566/amplitudo.v2i2.103

M. Duskri, Afrizal, & Susanti. (2024). Analysis of Students' Mathematical Literacy in Solving Problem-Solving Questions Based on Self-Regulated Learning. *Mosharafa: Jurnal Pendidikan Matematika*, *13*(3), 575–584. https://doi.org/10.31980/mosharafa.v13i3.2180

Madyaratri, D. Y., Wardono, & Prasetyo, A. P. B. (2019). Kemampuan Literasi Matematika Siswa pada Pembelajaran Problem Based Learning dengan Tinjauan Gaya Belajar. *Prisma, Prosiding Seminar Nasional Matematika*, 648–658.

Mardhiyah, R. H., Fajriyah Aldriani, S. N., Chitta, F., & Zulfikar, M. R. (2021). Pentingnya Keterampilan Belajar di Abad 21 sebagai Tuntutan dalam Pengembangan Sumber Daya Manusia. *Lectura: Jurnal Pendidikan*, *12*(1), 29–40.

Maslihah, S., Waluya, S. B., Rochmad, K., Karomah, N., & Iqbal, K. (2021). Increasing mathematical literacy and learning independence through a problem-based learning model with a realistic mathematical education approach. *Journal of Physics: Conference Series*, *1918*(4). https://doi.org/10.1088/1742-6596/1918/4/042123

Monsang, P., Srikoon, S., & Wichaino, N. (2021). The effects of problem-based learning for enhancing science problem-solving skills. *Journal of Physics: Conference Series*, *1835*(1). https://doi.org/10.1088/1742-6596/1835/1/012016

Nugroho & Azizah. (2024). Penerapan Model Pembelajaran Kooperatif Tipe Teams Games Tounament Untuk Meningkatkan Keaktifan dan Prestasi Belajar Pendidikan Pancasila Kelas V Sekolah Dasar. *Jurnal Ika: Ikatan Alumni PGSD Unars*, *15*(1), 57–67.

OECD. (2021). PISA 2021 Mathematics Framework (Second Draft). *Angewandte Chemie International Edition, 6(11), 951–952.*, *November 2018*, 5–24. http://www.oecd.org/pisa/pisaproducts/pisa-2021-mathematics-framework-draft.pdf

Prastika, A., Susilo, A., & Isbadiyah. (2024). The Application Of The Problem-Based Learning (PBL) Model To Improve The Learning Outcomes Of History Class X SMK PGRI Air Beliti. *Jurnal Eduscience*, *11*(2), 356–367.

Putri Assani Rohmatus Sa'adah, & Agung Nugroho. (2020). Implementasi Model Problem Based Learning Berbantuan Media Papan Kantong Untuk Meningkatkan Motivasi Belajar Siswa Kelas IV SD Negeri 2 Bantar Pada Mata Pelajaran Pendidikan Pancasila. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *8*(1), 135–141.

Putri Sabiq Shidiqia Rabany, Agung Nugroho, & Ratih Febrianti. (2025). Implementasi Model Problem Based Learning (PBL) dengan Pendekatan Culturally Responsive Teaching untuk Meningkatkan Numerasi Siswa Kelas V. *Social, Humanities, and Educational Studies*, *8*(3), 2285–2291.

Rahma, N. A., Sugilar, H., & Suprianti, D. (2024). Peran Literasi Matematika pada Kemampuan Berpikir Kritis Siswa. *Jurnal Analisa*, *10*(2), 116–126. https://doi.org/10.15575/ja.v10i2.40262

Sastrawati, E., & Budiono, H. (2025). Mathematics Comics Based on Problem-Based Learning with Illustrations of Jambi Culture. *Jurnal Eduscience*, *12*(1), 217–231.

Simarmata, Y., Wedyawati, N., & Rejeki Hutagaol, A. S. (2020). Analisis Literasi Matematika Pada Penyelesaian Soal Cerita Siswa Kelas V Sekolah Dasar. *Jurnal Pendidikan Matematika, 2(1), 100–105*, *2*(1), 100–105.

Suradika, A., Dewi, H. I., & Nasution, M. I. (2023). Project-Based Learning and Problem-Based Learning Models in Critical and Creative Students. *Jurnal Pendidikan IPA Indonesia*, *12*(1), 153–167. https://doi.org/10.15294/jpii.v12i1.39713

Susilawati, S., & Supriyatno, T. (2023). Problem-Based Learning model to improve elementary school students' critical thinking abilities. *Advances in Mobile Learning Educational Research*, *3*(1), 638–647. https://doi.org/10.25082/amler.2023.01.013

Wijnia, L., Noordzij, G., Arends, L. R., Rikers, R. M. J. P., & Loyens, S. M. M. (2024). The Effects of Problem-Based, Project-Based, and Case-Based Learning on Students' Motivation: A Meta-Analysis. In *Educational Psychology Review* (Vol. 36, Issue 1). Springer US. https://doi.org/10.1007/s10648-024-09864-3

Wiratama, P. P., Sunu, W., Dwandaru, B., Kuswanto, H., & Laeli, S. (2025). Effectiveness of Problem-Based Learning in Enhancing Critical Thinking Skills in Science Education : Meta-Analysis. *Jurnal Eduscience*, *12*(4), 1015–1028.

Yekti, S. M. P., & Mufarrihah, I. (2022). Analysis of Students' Numerical Literacy Ability at the Elementary School Level. *Pedagogik Journal of Islamic Elementary School*, *5*(1), 153–160.

Yuslia Fendy, L. E., Mariana, N., & Ekawati, R. (2025). the Effectiveness of Ethnomathematics-Based Lkpd Development in Improving Mathematical Literacy. *JIPI (Jurnal Ilmiah Penelitian Dan Pembelajaran Informatika)*, *10*(2), 1585–1594. https://doi.org/10.29100/jipi.v10i2.7713